A COMPARATIVE STUDY OF COYOTE FOOD HABITS ON TWO UTAH DEER HERDS

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Abstract.— Coyote (*Canis latrans*) scats from two southern Utah deer herd units were collected and analyzed to establish diet selection. The category showing the most consistent frequency of occurrence was mule deer *Odocoileus hemionus*; lagomorphs were next. Formal statistical analysis revealed that the only significant difference in coyote food habits between herd units was in the frequency of rabbits eaten. These data suggest that coyotes in this region of southern Utah show a comparatively higher preference for mule deer but, at the same time, do not eat deer in proportion to the frequency of their occurrence.

Documented reductions in deer populations in most southern Utah mule deer (*Odocoileus hemionus*) herds have led to speculation concerning the cause or causes for these declines (Workman and Low 1976). This paper investigates the hypothesis that coyote (*Canis latrans*) predation may reflect differential selection for deer. This was done by assessing coyote food habits in two adjacent deer herd units in southern Utah's San Juan County. Areas studied included the Blue Mountain (31A) and Elk Ridge (31B) herd units. Since the deer population is known to be larger within the Blue Mountain unit (Jense 1981), an examination of coyote scats from both areas could indicate whether deer occur in coyote diets in relationship to herd size. If this relationship was positive at a high level of significance, it would lend some credence to the coyote predation hypothesis.

Study Area

The San Juan-Blue Mountain deer herd unit (31A) is, for the most part, that portion of San Juan County east of the North and

Table 1. Relative frequency of occurrence of food items in coyote diets as determined from 460 scats collected from September 1977 to December 1979.

		Blue Mountain						
Period[a]	(n)	Vegetation	Rodent	Deer	Lagomorph	Cattle	Bird	Carrion
1	(18)	11.1	11.1	44.4	48.9	0.0	5.6	0.0
2	(15)	26.7	20.0	46.7	33.3	0.0	0.0	0.0
3	(105)	23.8	3.8	61.0	15.2	1.0	1.0	6.7
4	(41)	4.9	0.0	14.6	87.8	0.0	2.4	0.0
5	(12)	16.7	16.7	16.7	91.7	0.0	0.0	0.0
6	(62)	21.0	16.1	58.1	33.9	1.6	1.6	30.6
7	(37)	59.5	40.5	37.8	13.5	10.8	10.8	21.6
8	(12)	14.3	50.0	46.4	25.0	17.0	10.7	0.0
Total[b]	(318)							
mean[c]		26.8	19.8	40.7	42.4	3.9	4.0	7.4
Standard deviation[c]		16.60	17.27	17.17	30.56	4.81	4.52	12.04

[a]*Period*	*Dates*
1	Sep–Dec 1977
2	Jan–Jun 1978
3	Jul–Sep 1978
4	Oct–Dec 1978
5	Jan–Mar 1979
6	Apr–Jun 1979
7	Jul–Sep 1979
8	Oct–Dec 1979

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South Cottonwood drainages. Its highest point is Abajo Peak at 11,360 ft (3,463 m), and it ranges to a low elevation at Bluff City of 4,473 ft (1,363 m). The summer range area of this unit is 153 mi² (396 km²), and the area of the winter range is 1,394 mi² (3,610 km²). Major vegetational types within this unit are conifer, aspen, mountain brush, sagebrush, pinyon-juniper, and blackbrush (Coles and Pederson 1968, 1969).

The San Juan-Elk Ridge deer herd unit (31B) is that area of San Juan County west of the North and South Cottonwood Wash drainages. Horse Mountain, at 9,320 ft (2,840 m) elevation, is the highest point; and the lowest is also at Bluff City, which divides these two herd units. The area of the summer range is 195 mi² (505 km²), and that of the winter range is 1,132 mi² (2,932 km²). Major vegetational complexes include conifer, aspen, mountain brush, sagebrush, pinyon-juniper, and salt desert shrub (Coles and Pedersen 1968, 1969).

During the period from 1976 to 1979, the number of deer harvested per 1000 ha of summer range was 2.9 for the Blue Mountain unit and 1.10 for the Elk Ridge unit. The number of deer harvested per hunter day (effort) for the same time period was 0.061 and 0.049, respectively.

Materials and Methods

Data on dietary selection were obtained from analyses of coyote scats collected along established roads. Scat analysis was chosen over stomach content analysis because a larger sample size could be collected during specific time periods and at specified localities without diminishing the predator population (Knowlton 1964, Meinzer et al. 1975). Scats were collected every three months during a 27-month period from 1 September 1977 to 31 December 1979, with the exception of a 6-month lapse during period 2. Scats were air dried for a minimum of 30 days and then analyzed after thoroughly crumbling. All remains were identified with the aid of a binocular dissecting microscope, hair (Moore et al. 1974), and feather keys, as well as a reference collection of skeletons and vegetation.

Table 1 continued.

	Elk Ridge						
(n)	Vegetation	Rodent	Deer	Lagomorph	Cattle	Bird	Carrion
(0)	–	–	–	–	–	–	–
(4)	0.0	0.0	50.0	25.0	50.0	0.0	0.0
(26)	19.2	15.4	57.7	19.2	3.8	0.0	3.8
(5)	0.0	0.0	80.0	20.0	0.0	0.0	0.0
(22)	9.1	0.0	18.2	81.8	4.5	0.0	0.0
(18)	16.7	16.7	72.2	33.3	0.0	5.6	5.6
(31)	77.4	58.1	25.8	9.7	6.5	0.0	3.2
(36)	8.3	9.3	27.8	86.1	5.6	2.8	0.0
(142)	18.7	14.1	47.4	39.3	10.1	1.2	1.8
	26.92	20.71	24.13	31.33	17.80	2.20	2.36

[b]63.2 and 74.6 percent of all scats contained unidentifiable material from the Blue Mountain and Elk Ridge herd units, respectively.
[c]Computed as the average overtime periods

Food habits are reported as relative frequency of occurrence.

Comparisons between the two coyote populations were made using three statistical procedures, viz., normal approximation to two sample binomial data (Snedecor and Cochran 1967), stepwise logistic regression (Fienberg 1980), and stepwise discriminant analysis (Morrison 1976). The statistical computing programs P1F, PLR, and P7M, respectively, were employed from the BMDP series (Brown 1977).

In the first statistical procedure, each scat was considered to represent a bernoulli trial for each category of remains identified. Hence the total number of scats from each herd unit was treated as a binomial random sample, of which a certain proportion contained remains but the complement did not.

In the second procedure, we treated the location (herd unit) category as a "response" variable and all other dichotomous categories of identified remains as "design" or explanatory variables. The logic of the response variable was then regressed on the explanatory variables.

In the final procedure, each scat was considered to be a multivariate observation, i.e., a vector of remains categories. Discriminant analysis was then used to determine which variables (categories) best discriminated between the two groups (herd units).

Results and Discussion

We collected and analyzed 460 coyote scats: 318 from the Blue Mountain unit and 142 from the Elk Ridge unit. Equal search effort was not expended on both areas, and scat numbers are not indicative of coyote numbers. The major food items found in the scats from both areas were mule deer, birds, carrion, lagomorphs (black-tailed jackrabbit [*Lepus californicus*], mountain cottontail

Table 2. Summary of coyote dietary studies

Authority		Study area	Sample size	Source
Bond	1939	California	282	S and S
Murie	1940	Yellowstone National Park	5,086	Scats
Sperry	1941		8,339	Stomachs
Murie	1945	British Columbia	311	Scats
	1945	Montana	286	Scats
	1945	Montana	67	Scats
Fitch	1948	California	1,173	Scats
Ferrel et al.	1953	California	2,222	Scats
Fichter et al.	1955	Nebraska	747	Stomachs
	1955	Nebraska	2,500	Scats
Korschgen	1957	Missouri	770	Stomachs
Korschgen	1957	Missouri	326	Scats
Ozoga[b] et al.	1966	Michigan	92	Scats
Gier	1968	Kansas	1,451	Stomachs
Clark	1972	Utah and Idaho	186	Stomachs
Hawthorne	1972	California	384	Scat
Mathwig	1973	Iowa	151	Stomachs
Richens et al.	1974	Maine	51	Stomachs
Gipson	1974	Arkansas	168	Stomachs
Meinzer et al.	1975	Texas	514	Scats
	1975	Texas	55	Stomachs
Niebauer et al.	1975	Wisconsin	3,353	S and S
Nellis et al.	1976	Alberta, Canada	344	Stomachs
Johnson et al.	1977	Arizona	224	Scats
Ribic[c]	1978	Colorado	54	Scats
Neff et al.	1979	Arizona	65	Scats
			102	Scats
Litvaitis et al.	1980	Oklahoma	361	Scats
Springer and Smith[c]	1981	Wyoming	404	Scats

[a]Percent could not be determined from data presented.
[b]Winter study only.
[c]Summer study only.
[d]Largely carrion; innards, heads, and feet.

[*Sylvilagus nuttallii*]), rodents (rock squirrel [*Spermophilus variegatus*], least chipmunk [*Eutamius minimus*], Apache pocket mouse [*Perognathus apache*], and deer mouse [*Peromyscus maniculatus*]), and vegetation (Table 1).

When results of our study are compared to data collected in 23 previous studies of coyote diets (Table 2) dating from 1939 through 1981, only two show deer occurring in the diets with greater relative frequency (Ozoga and Harger 1966, Hawthorne 1972). Coyote diets from both our study areas also showed a higher relative frequency of carrion than most other studies reported (Table 2). However, since it was difficult to postively identify carrion during the winter months, this category was not included in the statistical analyses reported hereafter. The greatest amount of fluctuation from one time period to another occurred in the category of lagomorph remains. Mule deer were the dietary item showing the most consistent use (highest relative frequency) across collection periods occurring in four out of eight and four out of seven collection periods for the Blue Mountain and Elk Ridge herd units, respectively. Lagomorphs were the second most consistently used food item identified in scats, occurring in two of eight and two of seven collection periods, respectively. Analysis suggests coyotes could be a factor in the fluctuations of deer populations in these southeastern Utah herd units. These results do not constitute evidence for a cause and effect relationship. Mule deer may be killed and eaten by coyotes or they may be eaten as carrion. Deer carrion could occur as a result of winter stress, other predators, disease, parasites, or other factors, but the reason for these mortality factors warrants further investigation.

Table 3 contains the single category comparisons of binomial proportions between

Table 2 continued.

Percentage of specimens in which item occurred						
Lagomorphs	Rodents	Carrion	Livestock	Birds	Deer	Vegetation
38.8	62.5	4.2	8.8	2.5	26.1	16.9
4.0	59.9	0.0[a]	0.1	3.1	1.0	2.0
43.0	32.0	25.0	20.0	13.0	6.0	4.0
69.4	6.1	9.2	6.6	7.4	4.6	1.8
31.8	40.1	12.6	0.0	3.5	1.1	2.4
52.7	1.7	8.9	6.4	12.9	1.1	3.2
45.4	43.7	1.0	1.0	2.0	0.0	3.0
29.3	49.1	0.0[a]	23.2	18.1	18.5	0.0[a]
58.2	0.0[a]	0.0[a]	26.1	44.1	0.4	3.6
23.0	0.0[a]	0.0[a]	30.5	33.7	7.6	16.0
55.3	36.3	8.6	13.8	22.0	2.9	7.9
80.4	33.3	0.0[a]	2.8	14.7	0.0	23.5
17.0	69.8	83.0	2.1	5.1	91.4	19.8
54.3	41.5	37.7	0.0[a]	24.8	0.0[a]	3.1
84.0	15.0	0.0[a]	10.3	2.1	2.0	1.6
5.7	74.2	0.0[a]	1.5	3.7	35.2	45.3
61.0	37.7	0.0[a]	31.1	21.2	0.0	64.2
19.6	19.6	0.0[a]	11.8	19.6	15.9	78.4
7.0	9.0	30.0	13.0	44.0	5.0	36.0
10.5	24.5	6.0	0.0	1.1	0.0	48.5
10.8	20.2	21.1	0.0	4.5	0.3	20.5
28.0	21.0	0.0[a]	0.0	12.1	26.9	36.2
3.0	22.0	0.0[a]	44.0[d]	11.0	0.0[a]	7.0
27.0	19.4	0.0[a]	0.0	18.6	0.0	4.5
24.0	45.0	0.0	0.0	30.0	13.0	78.0
26.2	43.0	0.0	15.4	1.5	12.3	32.8
0.0	38.2	0.0	6.9	34.3	2.0	39.5
11.0	53.0	0.0	6.0	19.0	20.0	32.0
63.0	45.0	0.0[a]	0.0[a]	0.0[a]	5.0	42.0

herd units. Normally we would conclude a significantly higher (p = 0.27) proportion of coyote scats from the Elk Ridge herd unit contained lagomorph remains than did that of the Blue Mountain unit, but such a conclusion would be somewhat misleading. All tests reported in Table 3 are not independent of one another since the information in each came from the same sample of coyote scats. One generally acknowledged and conservative interpretation of these kinds of results uses a Bonferroni procedure (Neter and Wasserman 1974) in which the level of acceptable Type I error is divided by the number of simultaneous tests (six in this investigation). Hence, the "appropriate" significance level for the results in Table 3 (assuming P = .05) is .008, in which case none of the test results are significant. It is interesting to note that the only other category approaching the point of demonstrating even weak evidence in favor of a difference in coyote diets between herd units was deer. The results of the stepwise discriminant analysis indicated the most important variable (category) to significantly discriminate between groups was lagomorphs (approx. F-statistic at 1st step = 4.941, p = .027). Similarly, the results of the stepwise logistic regression analysis indicated lagomorph remains were the only variable to account for a significant (x^2 = 4.859 at 1st step, p = .028) amount of variability in the logit (response) variable.

These results suggest coyotes do not include deer in their diets based on the potential frequency of occurrence of this food item. However, we did not conduct any simultaneous census of deer numbers in either of the areas where scats were collected. Further investigation is warranted.

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TABLE 3. Cell frequencies and statistical test results when each category of coyote scat material is considered to be a normal approximation to a two-sample binomial problem.

		Lagomorphs			Deer		
		Present	Absent	Total	Present	Absent	Total
Deer herd	1	111	207	318	151	167	318
	2	65	77	142	56	86	142
Total		176	284	460	207	253	460
		P_1^a = .349		P_2^b = .458	P_1^a = .475		P_2^b = .394
		z = 2.216		Prob. = .027	z = 1.603		Prob. = .109

		Birds			Cattle		
		Present	Absent	Total	Present	Absent	Total
Deer herd	1	10	308	318	12	306	318
	2	2	140	142	8	134	142
Total		12	448	460	20	440	460
		P_1^a = .031		P_2^b = .014	P_1^a = .038		P_2^b = .056
		z = 1.079		Prob. = .280	z = .904		Prob. = .366

		Rodents			Vegetation		
		Present	Absent	Total	Present	Absent	Total
Deer herd	1	52	266	318	77	241	318
	2	28	114	142	36	106	142
Total		80	380	460	113	347	460
		P_1^a = .164		P_2^b = .197	P_1^a = .242		P_2^b = .254
		z = .880		Prob. = .379	z = .263		Prob. = .793

1 = Blue Mountain
2 = Elk Ridge

[a]Proportion of scats collected from the Blue Mountain Range containing the indicated remains
[b]Proportion of scats collected from the Elk Ridge Mountain Range containing the indicated remains

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